

# **Framework for Residential Energy Labeling**

Prepared by David Heslam and Iain Walker

May 4 2010

The following white paper was the product of an exercise to reach consensus amongst a wide group of stakeholders on an approach to energy modeling, rating, and labeling of residential buildings. It is our hope that using this as a starting point, there will be an open and ongoing discussion leading to specific actions to move rapidly to a national system that will deliver a harmonized approach to how we measure and communicate energy use in residential buildings.

The following people contributed to this initial effort:

Steve Baden, Michael Blasnik, Richard Faesy, Philip Fairey, Diane Ferington, Asa Foss, Rick Gerardi, Matt Golden, Bruce Harley, David Heslam, Sean Penrith, Greg Thomas, Joel Truher

## Summary

This paper proposes a framework for national standards regarding residential energy labeling and energy retrofit audits. There is a growing consensus around the importance of a national building energy labeling standard in the residential sector. Such a standard would serve to stimulate energy efficiency and its associated carbon emission reductions in the built environment. The standard would apply to Energy labels generated by simple audits as well as more in-depth retrofit audits that provide finer resolution of energy modeling require for estimates for financing, incentives, and upgrade decision-making.

Even though these two types of energy analysis serve different but related purposes, the two must be harmonized in their delivery and methodology. Both are in need of a unified set of standards. This paper recommends actions to implement the energy labeling standards that will ensure synergy of these audits in the marketplace.

The concepts presented here stem from a representative group of residential energy efficiency industry members, working under no particular affiliation. The proposal is intended to form the basis for continued discussion by a broader group of industry and government representatives.

The recommendations described in this paper are:

- An energy label should be an asset value.
- An energy retrofit audit should produce savings estimates that include operational values
- Home energy performance should be expressed in terms of three metrics: site energy by fuel type, associated carbon emissions and site energy costs.
- For natural gas the carbon emissions can be calculated directly from the site burned fuels natural gas, propane or wood. For electricity, the simplest and most robust carbon conversion method is to use a national average conversion factor.
- Two levels of granularity are recommended for the metrics.
  - 2500 kWh resolution for a building energy label.
  - 250 kWh resolution for Energy Audits.
- A minimum set of required data fields to be collected for labeling and energy audits should be defined by DOE in consultation with stakeholders. The data set collected may vary with the purpose of the calculation and type of rating.
- DOE should investigate the technical requirements and marketing pathways for a broad range of potential users.

- DOE should provide funding for development of improved calculation methods for estimating energy use. This includes, but is not limited to, development of ANSI/ASHRAE Standard 140 and the BESTEST-EX evaluation procedures.
- As data are collected for audits that include both the energy use estimates and bills - these data should be captured in a national database and used as a tool to improve future modeling/energy estimating efforts.
- DOE should adopt minimum standards for training and certification of auditors in consultation with industry, but should default to industry standards until such time that a consensus standard has been developed.
- A signed utility bill release form by building owners should be a prerequisite to acceptance of Federal energy efficiency incentive funds.

Members of industry endorsing this paper stand ready to assist the administration in the development of these standards.

### **Potential Users and End-uses**

The details of what is included on the label, its physical appearance, and other attributes depend on both the user and end-use of the label. It is possible that some aggregation could simplify the development of label marketing strategies. One way to aggregate could be by end uses, such as real estate transaction, home improvement, remodeling, equipment replacement and meeting minimum code requirements. A second way to aggregate is by user categories that can be broken down into two groups:

1. Those who already perform activities related to labeling (this includes both contractors and program managers), such as: HERS raters/consultants, Home Performance with Energy Star contractors, home inspectors, low income weatherization and remodelers.
2. Those for whom energy assessment of homes is a new idea: home buyers, home sellers, homeowners thinking about renovation/retrofit, realtor, mortgage broker, loan officer, appraiser, builder, utilities, ESCOs, state energy offices and energy efficiency program managers.

In both developing the label and marketing the label to get it adopted we need to understand the different needs/requirements of these groups and target them accordingly by going through channels they already use, for example contractors can best be reached via national retailers and HVAC equipment distributors.

For each group we need to consider the purpose of the label. Examples are: to allow financing for mortgage brokers and loan officers, personal pride for homeowners, and identification of target homes for utility programs.

What needs to be developed is a strategy for the technical aspects of what is included on a label and how to ensure that the label is used that is applicable to all these potential end uses and users.

### **Asset Values and Operational Values are Different**

An asset value label provides an assessment of energy use of the home based on the physical characteristics built into the home and a standardized set of operating characteristics. The specific characteristics taken into consideration for producing a label are dependent on the level of accuracy required. An operational value label is based on the actual energy use of a home. An operational value can be used to help improve the accuracy of an asset value label via calibration of the underlying physical building simulation.

### **Energy Labels Should Be Asset Values**

It is recommended that an energy label be an asset value, this will allow the label to represent the comparative energy consumption of a building. A likely use of asset labels is at time of sale of a home (DOE is initiating a pilot study with HUD/FHA at the time this document is being prepared that will provide useful information on this topic). Given the intrinsic change in occupants, the asset label is vital because billing data may not be a good indicator of energy use by different occupants.

Standard operating conditions need careful definition for an asset label to be effective across housing types, sizes and geographic areas. RESNET has created a recognized methodology for defining standard operating conditions. This methodology, which provides for lighting, appliances, miscellaneous plug loads, standard heating and cooling set points, should be updated by further development of standards for lighting, appliance and miscellaneous load modeling. Significant installed end uses such as saunas, hot tubs, and pools should also be considered in asset ratings. To make results comparable to actual energy bills and to the operational value label, DOE should explore the possibility of developing an energy calculation standard that include estimates of all installed end uses on the asset label. Those end uses not permanently installed in the building should be set at occupancy-neutral default values. Ongoing research into lighting, appliance and miscellaneous load use should be incorporated into this standard over

time to ensure that the asset label is reflective of typical consumption patterns.

### **Energy Audits Should Utilize Operational Values to Predict Savings**

An operational value label in its simplest form is the actual energy consumed by a building. Normalizing previous utility bills for weather would provide standardization of this type of information. This operational value would provide the energy consumption of the building as it is used by the current occupants. It is this value that should be used for predicted savings when building occupants are to remain the same. Energy Audits that are tasked with generating specific work scope and estimating detailed energy savings by individual upgrade for individual homes and occupants should utilize an operational value.

### **Accuracy of Energy Modeling Software**

Building energy labels need to be trustworthy, consistent and widespread to be effective. This is best achieved by having energy labels and energy savings predictions produced by the most accurate modeling software available. Current models often perform poorly because of a combination of three issues:

1. Occupant variability: number of occupants, hours of occupancy, pets, frequency of laundry/showering/eating at home, etc.
2. Problems with physical representation: thermal distribution losses, buffer spaces (attics, crawlspaces and attached garages), ventilation, foundation heat loss, hot water use, and
3. User input estimates and user understanding of requested input data.

The first of these issues requires detailed questioning and honest answering of questions by occupants. For an asset label this is overly burdensome, but for operational rating whoever is performing the rating will require this level of detailed interaction on order for a good work scope to be developed and will be a requirement for successful work.

The second issue can be addressed through engineering analyses, field studies and partnership with other industry bodies, who are also addressing these issues. It is recommended that DOE fund research and collaborative efforts in this area.

The third issue needs DOE sponsored research to determine which input data are most critical and efforts on clarifying default inputs and on input

strategies that make it less likely that input errors are made and that help users to understand the input data.

To further address these issues it is recommended that DOE undertake substantial field studies (on the order of thousands of homes) in order to evaluate occupant survey protocols, develop databases for model comparison and development, and for potential users to learn the requirements, limitations and to develop a core understanding of home energy labeling. DOE should maintain a database of homes that have undergone labeling and/or audited retrofitting to facilitate progress in this area.

To address issue of trust and consistency, there needs to be an arbiter of equivalency for energy estimating tools. DOE is ideally situated to be this arbiter. Therefore DOE needs to develop both the technical and administrative mechanisms for certifying energy estimating tools. The current technical method is best served by using BESTEST-EX while working on improving technical aspects of the procedure including more detailed comparisons to measured field data and automated model calibration. recognizing the shortcomings associated with comparing models to other models rather than measured data. The administrative mechanism needs to be created whereby DOE certifies, and documents this certification, of energy estimating tools that may be used for labeling.

DOE's own home energy rating software, Home Energy Saver (HES), should be further developed as a tool suitable for labeling. Advances to HES should be integrated with development of BESTEST-EX and other methods of comparing rating tools. DOE should support large scale field studies in hundreds of homes to provide the data required for model improvements and assessing model accuracy.

DOE should set reasonable accuracy limits for modeling software. An example would be: *"Over a large sample of homes more than half the predictions must be within 25% of the actual energy use from billing data and the average error must be less than 20%".*

## **Defining the Home Energy Label**

There are two main issues to address in defining a home energy label. The first is the selection of metrics to include on the label and the second is the graphical format.

It is recommended that the asset label contain two metrics: total site energy by fuel type and total estimated carbon emissions. The operational label should add the total cost of site energy.

The most likely candidate for carbon conversion factor is to use a single national value. This national value should be based on gas turbine generated electricity because the majority of marginal electricity is generated this way. Similarly, the cost of site energy should be a national average value for the asset label. DOE has plans to have a national database of labeling information such that the cost of energy could be updated periodically as energy costs change.

It is recommended that two levels of granularity be utilized for generating labels. Although calculations could be performed with higher resolution, asset values should have labels with energy consumption defined by steps of 2500 kWh (10 MBtu). Operational values resulting in an actionable work scope will require more detailed energy analysis and would generate labels with steps of 250 kWh (1 MBtu). The label will include the fuel use breakdown in kWh, therms, gallons of oil or propane, cords of wood, etc., to match what a homeowner sees on their bills.

In addition to the energy metrics it is recommended that the following information be included in the label: water use and top 5 end uses. For various potential users of the label, other information should be optional, such as: comparison to other similar homes, comparison to a new code compliant home, comparison to a reach target (e.g., 35% better than code), and recommendations for home energy upgrades.

## **Data Collection Requirements**

Data collection requirements for building energy labeling and energy auditing should be standardized. There should be separate standards for energy labeling audits and energy retrofit audits. It is recommended that the minimum set of data to be collected should be defined by DOE in consultation with stakeholders to ensure that the data collected would be compatible with the requirements of a national database.

Data collection standards go beyond just what data are collected for each home, but also how the data are collected. A prerequisite for a successful building energy label program is that the system is viewed as trustworthy so the technical standards for data collection should reference existing audit standards developed by industry. Standards for collecting data to generate energy labels should introduce the use of diagnostic equipment.

Additionally, a standard protocol for communicating audit data between database systems should be developed and standardized. Standardized forms should be developed by DOE that are required to be completed in order that retrofits are eligible for Federal funding. DOE should establish a national database of labeling data. This database should be coordinated with other survey instruments, such as the Residential Energy Consumption Survey (RECS).

### **Rater Infrastructure**

With the current increase in demand for energy audits, pending federal legislation for financial incentives, and the potential implementation of a National Building Rating Program there is a growing need for a more robust energy rater infrastructure than currently exists. The industry itself has begun to address this need by overhauling the quality assurance processes at RESNET and BPI. Although rating is viewed as a public benefit and may be best served by government standards, the implementation of those standards should remain within industry. It is recommended that DOE adopt minimum standards for training and certification of auditors in consultation with industry.